objective, and subject, to be photographed. It is true we can expose a dry plate for trial, but then we must develop it immediately, and the time of developing a dry plate is about three times that of developing a wet one, and a dry plate is also about three times as costly as a wet one. Therefore the old wet collodion process is the best.

The collodion to be used should be an old one, and contain some free iodine. I have found that a mixture of "Anthony's red labeled" and "McCollin's delicate half-tone" collodions—both commercial articles—some five or six months old, gives very satisfactory results. The nitrate bath should contain forty grains of nitrate of silver to the ounce of water, and should be slightly acidulated with nitric acid. The developer should be a weak one: twelve to fifteen grains of the double salt ammonio-sulphate of iron to the ounce of water, containing a few drops of a solution of gelatin and acetic acid as a restrainer.

After the negative has been fixed in the usual way, with hyposulphite of soda or cyanide of potassium, it is almost always necessary to intensify it, which is easily done by flowing the plate while wet with a watery solution of iodine until the film becomes white; then it is to be washed under the tap and flowed with a solution of sulphide of ammonium, which imparts to the negative a dark brown color, and thus strengthens its printing quality.

The object to be photographed should be as thin as possible, because the lens will depict only one plane of it, and it should present as much contrast and differentiation of its elements as possible; this is especially the case in animal tissues, and when high powers are used, the focus should be taken with the greatest care *for one particular point to be brought out*; a general focus not particularly sharp in any one point, will not give a satisfactory negative.

The screen upon which the image is focused should be of plate glass, having an extremely fine ground surface on one side—the side next to the object. Such a surface can easily be prepared by flowing the glass plate with a good negative varnish, and when this is set but not yet dry, lightly breathing on it, when an extremely fine and even frosting of the surface will show itself, sufficient to arrest and reflect the rays of light forming the image.

In photo-micrography, as well as in ordinary microscopy, proper illumination of the object is of the greatest importance, and frequently a poor objective will show a better definition in the hands of a skilled manipulator than the best objective can when the light is not properly managed. In this one point lies the difficulty of photo-micrography, and it is the stumbling block over which so many fall who undertake to photograph microscopic objects.

As a general rule the best light is obtained when the back lens of the sub-stage condenser is about half an inch beyond the burning focus of the larger condenser in the shutter, that is about eight and a half inches from this condenser, and when the light is *absolutely central.* But this distance cannot be strictly adhered to, inasmuch as different objectives require different illumination. In practice, I find that in order to obtain the proper distance of the condenser for a particular objective, it is best to put a blood-slide, upon which the corpuscles are in one layer only, on the stage, and project the image on the screen, moving the condenser backward and forward until, when sharply focused, no concentric rings are seen in the disks. The object to be photographed can then be substituted for the blood-slide, and the light will be found to be all that is desired. *(Compendium of Microscopical Technology.)*

PROFESSOR HELMHOLTZ will issue a collection of his scattered scientific memoirs in the autumn.

PLANTÉ AND FAURE BATTERIES.

The annexed illustrations of the secondary batteries, which are exciting so much interest at the present time will, with the accompanying description, enable the reader to understand their construction. At the recent soirée given by the Council and academical staff of King's College, several forms of electric-lighting apparatus were used; but that which attracted most attention was a battery of forty-four accumulators of Faure's design, working twenty of Swan's lamps. The cells were charged in Paris by a Gramme machine, and were arranged in groups of four in cubical boxes, the whole being coupled up in series. The current supplied by this arrangement, shown by a galvanometer in the circuit while the lamps were alight, was about twenty-three webers, and was perfectly steady—the Faure battery yielding an almost equal current during the whole time, until the charge becomes exhausted, when it breaks down suddenly, without any noticeable warning. Mr. Spottiswoode also uses the Faure battery to work Swan

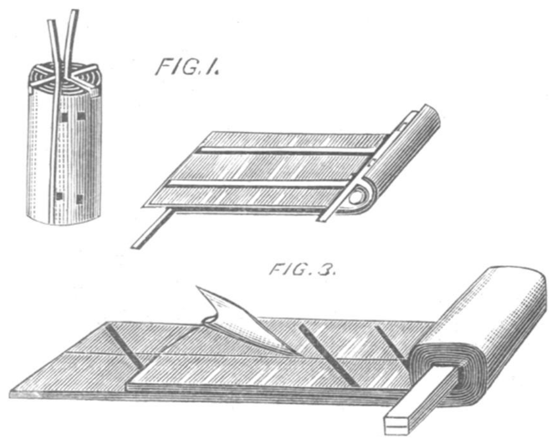

FIG. 1.

and Maxim lamps in his private house. Figs. 1 and 2 represent the Planté cell. The preparation is as follows: Two sheets of lead (it may be as thin as stout lead-foil) are laid the one on the other, separated by two strips of india-rubber, the whole being rolled up as shown in Fig. 1. The roll having been completed, the cylinder used in its formation is withdrawn, and it is consolidated by a wrapper of gutta-percha, and inserted in a glass jar filled with water and 1-10th part acid. An electric current is then made to pass through the cell; oxygen is given off, and produces a thick cushion of peroxide of lead on one sheet; hydrogen is given off at the other sheet. If the current with which the cell has been charged be cut off, and the two sheets are connected, a current will be produced, owing to the presence of the oxygen, which leaves the sheet where it has accumulated and attacks and oxidises the other sheet. This secondary current, which is very small at first, gains strength each time the operation is repeated; in course of time the surfaces of the sheets are changed, the one being covered with a cushion of peroxide of lead, the other with lead reduced to a spongy mass. The cell is then complete, and in a state of electrical accumulation. That was Planté's first successful battery. Subsequently he tried the plan of separating the two sheets of lead by canvas, the cell taking the form of Fig. 2. He then found that it was necessary to leave a small space between the sheets to provide for the escape of the gases which were produced at the end of the charge; subsequently india-rubber bands were employed in preference to canvas. M. Planté also tried carbonate of lead, minium, &c., but without improving upon the results already obtained. The

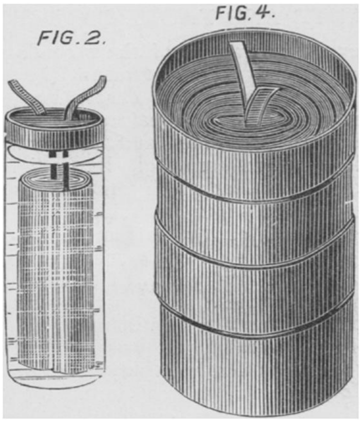

FIG. 2.

Faure battery is similar to the above:—Two sheets of lead are taken, about 7½in. wide; one about 23in. long and about 1-25th of an inch thick, the other 15in. long and 1-48 in. thick. Each of these is furnished with a strong strip of lead at one of its ends. Each sheet has a layer of red lead spread on its surface, the lead being made into a paste with water, the larger sheet having about 800 grammes on its surface, and the smaller 700 grammes. On each surface a sheet of parchment is laid, and the whole is introduced into a sheathing of thick felt. The sheets are laid one above the other; at the same time several bands of india-rubber are placed in an oblique fashion, as shown in Fig. 3. The roll is placed in a leaden jar strengthened by copper bands, and covered in the interior with red lead and felt. The cell then presents the appearance shown in Fig. 4. One of the pieces of lead which jut out is curved and soldered to the outer jar, acidulated water is put in, and the battery is ready for work.

We give the above figures as a guide, but there is no special reason for adhering to them, and it may be doubted whether either the parchment or felt is an absolute necessity; for good batteries have been constructed by painting stout lead-foil with red lead made into paste with water slightly acidified with oil of vitriol, and wrapping the plates in flannel or canvas which has been previously coated with the red lead paint. The painted surfaces are of course put together. Thin lead is used to keep the weight down as much as possible and to reduce the cost.

THE LESSON OF THE COMET; DOES IT SHOW A NEW FORCE?

By SAMUEL J. WALLACE, Washington. D. C.

There is one important consideration in relation to a comet and its tail which does not seem to have been properly noticed. A comet is generally supposed to be a mass, cloud or assembly of masses, particles and possibly gases, which travel together through the heavens, but do not actually form a single cohering body.

Now the remarkable point is this. When this assembly of matter of various sizes and conditions approaches the sun at a great velocity it seems to be acted upon by two forces in opposite directions at the same time, the one driving it forward toward the sun and the other driving it out away from the sun, and apart laterally.

And these two forces seem to act at different rates on different parts of the matter, so as to drive some parts forward, forming the head of the comet; to drive other parts forward with a less force, and spread them apart, forming the brighter part of the tail; while they act to actually drive other parts away into space, as the brush of the tail.

This is an action like that familiar to us in concentrating ores and in separating grain from the chaff. When ores are powdered fine and sifted down a shaft, up which a strong current of air is blown, the heaviest and richest particles fall through the opposing current to the bottom while the lighter and worthless particles are blown up and away. In this manner the rich ore is separated from the poor, and in a like way grain is separated from the chaff. This occurs because there are two forces acting against each other—the wind and gravitation—which act at different rates on the different particles and separate them.

The comet looks as if it was undergoing this very operation of concentration, or separation of the heavy parts from the light parts, under the action of gravity driving inward to the sun or some other opposing force driving outward and apart.

What makes this so remarkable is that the substance of the planets seems to have been separated in this very same manner. If we take the recognized specific gravities of the several planets and set them down in the order of their occurrence from Neptune, the furthest, inward to Mercury, the nearest the sun, beginning with one as the unit, we will find a gradual increase in weight per cubic foot from one for Neptune up to about nine for Mercury. If we set down the velocity of the planets in the same manner we will find the singular fact of an increase in the same way, from one for Neptune to about nine for Mercury. So that the velocity and the weight per foot increase together in a way that looks very suspicious of some connection between them.

What makes it look so singular is that the distance from the sun decreases almost in the very ratio of these two proportions multiplied into each other; or in the very way which it would do if the planets were formed of matter which had been concentrated by the heavy parts being driven toward the sun by gravity and the lighter parts being driven away by some other force—such as that which seems to be driving off the tail of the comet—so that each planet was formed of matter separated by its specific gravity in a general way, according to its distance from the sun and its velocity. Another thing which confirms this singularity is that the average weight of the meteoric masses which fall on to the earth, made up mostly of iron and some lighter rock, is very nearly that of the earth itself, taken as a whole, or about five and a half on the same scale, due to its position and velocity.

All this leads us to suppose that there is a force driving outward from the sun, as gravity drives toward it, but acting in proportion to the size of particles as gravity acts in proportion to their weight, which separates matter so that its average distance from the sun and its velocity shall conform to its average weight.

If this is true, as it seems, it throws light upon an obscure point, which may be considered as one of the most sublime within the reach of science; the nature of that wonderful mystery of gravitation itself, which holds and moves all the innumerable hosts of heaven in their everlasting circuits.

The course of modern thought is to render inconceivable the action of gravity as of an immaterial agent.

The theory of Lesage that it is the result of converging corpuscles of wave beats from all sides tending to drive bodies together is both sublime and in accordance with the habits of modern thought. But it utterly fails in one half of the problem. It does not explain what becomes of the dynamic energy of this force after it strikes a mass of matter, by which disappearance it is supposed to produce a shadow outward on all sides, to which the result of gravitation of masses to each other is attributed.

But if it should appear that there is a force thus going outward from the sun and other matter, as comets and planets in this way seem to indicate, then we are compelled to account for it also, which is the very force that Lesage's theory failed to show, and which his force requires for its complement.